Effective mass of phi mesons at finite temperature *

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For phi mesons, changes in their properties are interesting because they would affect the production rate in high energy nucleus-nucleus collisions, which probes the enhancement of strangeness in quark-gluon plasma phase [1]. Recently, it also has been suggested that a change of phi mass in hot hadronic matter might be a possible probe for the chiral phase transition in hot matter [2].

The effective mass of phi meson at non-zero temperature is examined with an effective chiral Lagrangian. We find that ϕ effective mass decreases with temperature and is reduced by about 20 MeV at $T = 200$ MeV. The dominant contributions come from kaon loops due to $\mathcal{L}_{\phi KK}$ and the $SU(3)_V$ symmetry breaking terms. As temperature increases effects from K^* mesons become important and increase the effective mass of phi meson.

Compared with the calculation done by K. Haglin and C. Gale [3], we do not have the large effect from kaon tadpole loops which increases phi mass. In our calculation we also have kaon tadpole loop corrections. However, these contributions come from $SU(3)_V$ symmetry breaking terms and show different effect. In the massive Yang-Mills approach which also includes vector mesons in chirally symmetric way, these tadpole loop contributions are exactly canceled by those from axial-vector-pseudoscalar loops [4]. This implies that chiral symmetry plays an important role in vector meson mass at finite temperature and shows different result. Calculations using QCD sum rules also show that the effective mass of phi mesons decreases with temperature. However, we have a small effect compared to the result obtained from in Ref. [2] and have an opposite result for K^* contributions. This difference requires more study in future.

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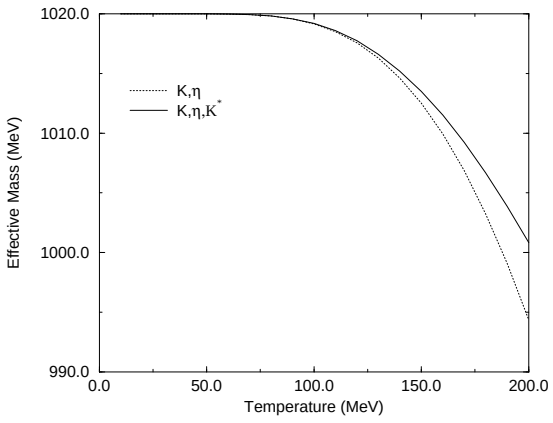

Figure 1: Effective mass of phi meson at finite temperature

A small change in ϕ effective mass makes it hard to observe the double phi peak in dilepton spectrum which has been suggested as a possible probes of chiral phase transition in hot hadronic matter. Since it has been estimated that the effective width of phi mesons in hot hadronic matter becomes about $20 \sim 30$ MeV, the mass shift obtained from the calculation will be within the effective width. With very accurate mass resolution, we might have a chance to see these small changes of the effective mass in dilepton spectrum. Details will also depend on the coupling of phi meson to photon which will be modified in hot hadronic matter as for ρ mesons.

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[4] Chungsik Song, Phys. Rev. D 53 (1996) 3962.